Volatility Impact of Stock Index Futures Trading - A Revised Analysis

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The recent financial crisis renewed concerns about a possible destabilizing impact of derivatives trading. Despite a very active research, the question whether or not derivatives tend to destabilize financial markets has not yet been answered to satisfaction. This contribution aims to revise the robustness of recent empirical findings and to remedy some methodological shortcomings of earlier studies. Acknowledging their practical relevance, we focus on futures and examine the volatility impact of DAX futures trading. Our results confirm a volatility-reducing impact of DAX futures trading, whereas the observed deterioration of the fundamental price building process proved to be statistically insignificant.

1. Introduction

It is a widely held belief among economists, finance experts and policy makers that derivatives pose a threat to financial market stability. The tremendous increase in derivatives trading since the late 1980ies and the regular occurrence of financial crises within the same time have fuelled this concern. Despite a very active research, the question whether or not derivatives tend to destabilize financial markets has not yet been answered to satisfaction.[1] This paper attempts to shed some additional light on this issue. Acknowledging their practical relevance, we focus on futures, particularly stock index futures, and examine the volatility impact of DAX futures trading.

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[1] Due to the adverse potential of financial market instability regarding the harmful economic effects of financial crises, the answer to this question is of central meaning and has opposing policy implications concerning the regulation of derivatives and their markets. For a recent analysis of the economic costs of financial market shocks see Chin and Warusawitharana (2010). For an overview about the concept of financial stability and its economic meaning see, e.g., Schinasi (2009, 2006).

So far the theoretical literature about the volatility impact of futures trading has come to conflicting conclusions depending on the assumptions about the informational role of futures. Proponents of a stabilizing effect argue that the introduction of a futures market increases the amount and/or quality of available information if speculators have an informational advantage in estimating future economic outcomes. It is argued that the higher informativeness of asset prices will lead to an improved resource allocation and a reduction in asset price volatility. If speculators are prone to estimation errors, however, or their information is not fully revealing to other market participants, futures trading lowers the informational content of asset prices, thereby increasing asset price volatility in the underlying cash market. Pioneering contributions to this line of argument stem from Danthine (1978), Turnovsky and Campbell (1985), Hart and Kreps (1986) and Stein (1987). Another argument pointing to a volatility enhancing effect of futures trading focuses on the price discovery process and the speed of processing new information rather than the amount of available information. This line of research applies the no-arbitrage martingale approach[2] to show that asset price volatility equals the rate of information flow if markets are efficient. Since transaction costs for futures are low, it is assumed that futures trading will increase the rate of information flow and thus – in the absence of arbitrage – the volatility in both futures and cash markets. According to this view, higher financial market volatility indicates a quicker rate at which new information is incorporated into asset prices and thus increased informational efficiency. See Ross (1989) for an early formalization of this argument.

More recent contributions try to resolve the issue on empirical grounds. Previous empirical studies analyzing the volatility impact of futures trading have primarily focused on the US stock market where stock index futures have been introduced first. Other stock indices have only been analysed occasionally. Empirical findings are still mixed, although more recent studies seem to be in favour of a volatility reducing impact of stock index futures trading. For a comprehensive overview about the empirical literature on this subject we refer the reader to Sutcliffe (2006). The impact of stock index futures trading on the volatility of the German stock market has only been analysed in

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[2] The no-arbitrage martingale approach has become a cornerstone of modern dynamic asset pricing theory. See, for example, Musiela and Rotkowski (2008) for a textbook introduction to martingale pricing.

multi-country studies (Antoniou *et al.*, 1998, 2005 and Gulen and Mayhew, 2000). Overall, the results of all these studies mainly suggest a decrease in the volatility of the corresponding stock market or no volatility impact at all.

Our contribution aims to revise the robustness of recent empirical findings and to point out and remedy some methodological shortcomings of earlier studies. We examine the volatility impact of DAX futures trading covering a data sample from January 1, 1970 to May 1, 2009 applying two approaches. First, we test for a structural break in the long-term volatility of DAX returns before and after the listening of the DAX futures contract. Second, we test for a structural break in the dynamics of the conditional volatility of DAX returns.

Our analysis supplements the existing research in several ways. Like Antonio and Holmes (1995) and Antonio *et al.* (1998) we apply the generalized autoregressive conditional heteroscedasticity (GARCH) framework to model financial market volatility. However, we do not restrict the model order ad hoc as most other studies because this procedure bears the risk that the GARCH volatility model is not properly specified and inferred results are not reliable. Rather we select the best fitting GARCH(p,q) specification up to a maximum order of $p = q = 5$ using the Akaike and Schwarz information criteria, a battery of residual diagnostic tests as well as relaxed parameter constraints from Nelson and Cao (1992) wherever applicable.

To the best of our knowledge, this paper is the first to examine whether the observed parameter changes of the descriptive pre- and post-futures analysis are actually significant. We apply the two-sample t-test for this purpose.

Our results confirm a volatility-reducing impact of DAX futures trading once the volatility impact of other market-wide factors unrelated to futures trading is properly accounted for. Our analysis demonstrates that the observed deterioration in the fundamental price building process in the post-future period is not significant according to the two-sample t-test. We further find that for our sample the GARCH(1,1) model is not the preferred model specification once other market-wide factors are taken into account. Applying this model specification nevertheless does not change the qualitative results. However, it would misleadingly suggest a post-future increase in volatility persistence.

This paper proceeds as follows. Section 2 describes the econometric methodology adopted. Section 3 presents the data used and discusses the main results. The final section summarizes and concludes.

2. Methodology

To test the volatility impact of futures trading reliably two necessary preconditions must be met. It is crucial to use an appropriate model of financial market volatility that captures as many empirical stylized facts of financial time series as possible and that also accounts for the volatility impact other market-wide factors not related to futures trading. Due to its statistical properties and practical relevance we apply the (generalized) autoregressive conditional heteroskedasticity (ARCH/GARCH) framework to model financial market volatility. Introduced by Engle (1982), ARCH model are the first formal attempt at modelling volatility clusters and fat tails – both being important empirical characteristics of financial time series.[3] One of the most influential and most prevalent model extensions is the GARCH model introduced by Bollerslev (1986). In GARCH models, the conditional variance equation is also dependent on lagged conditional variances in addition to lagged squared error terms. GARCH models are superior to ARCH models in that they allow a more parsimonious model specification.

Following Bollerslev (1986) we define a GARCH (p,q) model of financial market volatility as:

(1) $\qquad r_t = \mu + \epsilon_t, \quad \epsilon_t = z_t \sqrt{h_t}, \quad z_t \sim N(0,1), \quad \epsilon_t \big| \epsilon^{t-1} \sim N(0, h_t)$

(2) $\qquad h_t = \omega + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2$

Equation (1) represents the conditional mean of daily log-returns r_t of the asset under consideration. In the simplest way chosen here, r_t is modeled as a white noise process with an unconditional mean μ and stochastic error terms ϵ_t which are assumed to be conditionally normally

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[3] A short overview of these and other less robust characteristics of financial time series can be found, e.g., in Cont (2001).

distributed. z_t describes a normally distributed white noise process and ϵ^{t-1} is the information set. Under the assumption of conditional normality, standardized errors should be approximately normally distributed. It has been shown that even under this restrictive assumption GARCH models have proven to capture the basic characteristics of financial time series well, in general (cf. Lütkepohl, 2007).

To control for the volatility impact of other market-wide factors, the conditional mean equation is augmented with a proxy variable. Following Antonio and Holmes (1995) and Bologna and Cavallo (2002) we use the CDAX as surrogate index for which no derivatives products have been introduced. For daily log-returns of the CDAX index by r_t^{CDAX} equation (1) becomes:

$$(1a) \qquad r_t = \mu + \delta r_t^{CDAX} + \epsilon_t, \epsilon_t \left| \epsilon^{t-1} \sim N(0, h_t) \right.$$

Equation (2) represents the conditional variance h_t of error terms ϵ_t modeled as a weighted autoregressive process of q lagged values of squared error terms and p lagged values of the conditional variance as well as a constant parameter ω. The conditional variance of a random variable can only be meaningfully defined for strictly positive values. Another desirable property of GARCH volatility processes refers to the issue of stationarity. Bollerslev (1986) proved that the following parameter constraints have to be fulfilled to ensure that those conditions hold:

$$(4) \qquad \omega > 0, \alpha_i \geq 0, \forall i = 0, 1, ..., q, \beta_j \geq 0, \forall j = 0, 1, ..., p$$

$$(5) \qquad \sum_{j=1}^{p} \beta_j + \sum_{i=1}^{q} \alpha_i < 1.$$

For stationary $GARCH(p, q)$ processes a finite, constant unconditional variance which gives an expression for the long-term average level of volatility is defined as:

$$(6) \qquad \sigma^2 = \frac{\omega}{1 - \sum_{j=1}^{p} \beta_j - \sum_{i=1}^{q} \alpha_i}$$

As has been shown by Nelson and Cao (1992) the parameter constraints given by (4) and (5) are sufficient but not necessary to guarantee the existence of a positive conditional variance of GARCH processes and might often be too strict in practical applications. To overcome this

shortcoming, Nelson and Cao (1992) propose some relaxed parameter constraints for $\text{GARCH}(p,q)$ models of order $p = 1$ and $p = 2$. Wherever applicable we apply both parameter constraints in our model selection process.[4] In order to account for the possibility of higher order GARCH processes the best-fitting $\text{GARCH}(p,q)$ specifications are selected with the help of the Akaike and Schwarz information criterion up to an order of $p = q = 5$.[5] The appropriate model fit is checked with several residual diagnostic tests. Since the residuals of GARCH models are only conditionally normally distributed, diagnostic tests have to be applied to the standardized residuals $z_t = \epsilon_t / \sqrt{h_t}$. If the assumption of conditional normality holds, standardized residuals of a well-fitted model should resemble a white noise process characterized by fully irregular fluctuations and no autocorrelation. That is, they should show a constant mean and a constant variance with values of zero and unity, respectively. Their kurtosis should take a value of three and their skewness should have zero value. Furthermore, standardized residuals as well as squared standardized residuals should be serially uncorrelated and show no remaining ARCH effects.

Following the recent literature, two approaches are used to test for a possible volatility impact of DAX futures trading. First, the conditional variance equation is amended with a dummy variable D that takes zero value in the period before the introduction of the DAX futures contract on November 23, 1990 (pre-futures period) and a value of unity in the period after the introduction (post-futures period). Thus, equation (2) becomes:

$$(2a) \qquad h_t = \omega + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \gamma D$$

The sign and magnitude of the parameter γ indicates the impact of DAX futures trading on the conditional volatility of the DAX index. A significant and positive value of γ suggests an increase in the mean level of conditional volatility in the post-futures period and vice versa (Gannon and Au-

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[4] A detailed description of the model selection process and residual diagnostics is available from the authors upon request.

[5] We also examined $\text{ARMA}(m,n)$ $\text{GARCH}(p,q)$ model specifications in order to account for serial correlation in the conditional mean equation. Results were in line with the preferred $\text{GARCH}(p,q)$ models and are available from the authors upon request.

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Yeung, 2004). Second, the selected model specifications are estimated separately for the pre- and post-futures sub-sample. This second approach allows us to analyse the impact of DAX futures trading on the volatility of the DAX index in more detail, especially with regard to its impact on the fundamental price building process.

3. Data and Results

Our total data sample covers daily closing prices of the DAX and CDAX stock indices for the period January 1, 1970 to May 1, 2009. Raw data are transformed into daily log-returns. Missing values due to holidays are filled with the previous day closing price. This common procedure guarantees a continuous data sample which is necessary for estimating GARCH models. The data used are mainly provided by the database "Global Financial Data" supplemented with data from the online data service of the German newspaper "Handelsblatt". The final data sample amounts to 10260 observations. For the pre-and post-futures analysis the final data sample is divided into two sub-samples covering the period before and after the introduction of the DAX futures contract on November 23, 1990. All estimation results are obtained using the statistical software package EViews 5.1.

TABLE 1
Estimation Results for Selected Model Specifications, Whole Sample

	Excl. a Proxy Variable (Type I)		Incl. a Proxy Variable (Type II)		
	1st best	2nd best	1st best	2nd best	
	GARCH(1,3)	GARCH(1,1)	GARCH(4,1)	GARCH(2,1)	GARCH(1,1)
mean equation					
μ	4.28E-04 (0.000)	4.31E-04 (0.000)	-1.96E-05 **(0.483)**	-1.74E-05 **(0.540)**	-1.49E-05 **(0.614)**
δ	-	-	1.121 (0.000)	1.122 (0.000)	1.123 (0.000)
variance equation					
ω	2.62E-06 (0.000)	1.80E-06 (0.000)	4.10E-07 (0.067)	3.62E-07 (0.097)	2.95E-07 **(0.114)**
α_1	0.073 (0.001)	0.105 (0.000)	0.191 (0.000)	0.152 (0.000)	0.110 (0.000)
α_2	0.015 **(0.635)**	-	-	-	-
α_3	0.051 (0.076)	-	-	-	-
β_1	0.842 (0.000)	0.881 (0.000)	0.219 (0.009)	0.289 (0.000)	0.897 (0.000)
β_2	-	-	0.191 **(0.238)**	0.567 (0.000)	-

β_3	-	-	0.170 (0.082)	-	-
β_4	-	-	0.239 (0.099)	-	-
γ	2.13E-06 (0.087)	1.62E-06 (0.086)	-3.69E-07 **(0.101)**	-3.26E-07 **(0.138)**	-2.66E-07 **(0.156)**
$\sum_{j=1}^{p}\beta_j+\sum_{i=1}^{q}\alpha_i$	0.9842	0.9889	1.0204	1.0173	1.0134
ARCH-LM(1)	0.109 (0.742)	0.184 (0.668)	3.222 (0.073)	7.121 (0.008)	19.324 (0.000)
ARCH-LM(5)	1.163 (0.948)	2.337 (0.801)	3.427 (0.634)	7.639 (0.177)	20.464 (0.001)
ARCH-LM(10)	3.295 (0.974)	3.458 (0.968)	4.576 (0.918)	9.020 (0.530)	22.276 (0.014)
Q(1)	33.799 (0.000)	33.135 (0.000)	257.080 (0.000)	275.960 (0.000)	303.850 (0.000)
Q(10)	47.949 (0.000)	47.491 (0.000)	298.220 (0.000)	314.350 (0.000)	337.700 (0.000)
$Q^2(1)$	0.109 (0.742)	0.184 (0.668)	3.223 (0.073)	7.124 (0.008)	19.331 (0.000)
$Q^2(10)$	3.360 (0.972)	3.473 (0.968)	4.636 (0.914)	9.145 (0.518)	22.385 (0.013)
Mean	-0.020	-0.022	0.011	0.011	0.012
Standard	1.000	1.000	0.999	1.000	0.999
Kurtosis	10.290	11.135	18.691	19.306	18.227
Skewness	-0.646	-0.700	-0.495	-0.351	-0.426
JB	23429.78 (0.000)	29108.71 (0.000)	105667.10 (0.000)	114116.40 (0.000)	99430.23 (0.000)

Notes: Figures in parentheses (.) indicate QML estimated p-values. ARCH-LM(.) is the Lagrange multiplier test statistic of the null hypothesis of no ARCH effects of order T in the standardized residuals. Q(.) and Q2(.) are the Ljung-Box Q-test statistics of the joint null hypothesis of no serial correlation up to order T in the standardized respectively squared standardized residuals. JB is the Jaque-Bera test for normality.

The estimation results for the whole sample period are shown in table 1. For purposes of comparison the results for model specifications excluding a proxy variable for other market-wide factors (model type I) are also presented. The estimated coefficients of the conditional variance equation are mostly significant at least at conventional significance level. Standardized residuals do not fully satisfy the desirable white noise property showing some remaining higher order serial correlation for the selected GARCH(p,q) specifications as indicated by the significant Ljung-Box Q-test statistic. Furthermore, standardized residuals show some deviation from conditional normality as indicated by the highly significant Jaque-Berra test statistic, a high kurtosis statistic as well as some skewness for all selected model specifications. However, since the autocorrelation coefficients have near zero values and are, therefore, barely economically relevant, the significant Ljung-Box Q-test

statistics need not be mandatorily interpreted as a model misspecification. The deviation of conditional normality of standardized residuals on the other hand implies a misspecification of the log-likelihood function. Maximizing the log-likelihood for non-normal standardized residuals – which is called quasi-maximum log-likelihood (QML) estimation – can, nevertheless, be justified according to the asymptotic properties of the QML estimators. For stationary GARCH processes it is well documented that QML estimators are consistent and asymptotically normal (Bollerslev and Wooldridge, 1992; Lee and Hansen, 1994, as cited by Herwartz, 2007, p. 202f). Therefore, the QML estimation with Bollerslev-Wooldridge corrected standard errors is applied throughout the analysis to account for the deviation from conditional normality.

The sign of the estimated coefficients of the dummy variable γ is negative for all selected model specifications of type II indicating a volatility-reducing effect of DAX futures trading. In contrast, results for type I models would suggest a volatility-enhancing effect of futures trading.

Estimation results for the pre- and post-futures analysis are shown in table 2.[6] The estimated coefficients of the conditional variance equation are mostly significant at conventional significance level. As before, the results suggest a volatility decrease with regard to the mean level of conditional volatility indicated by a post-future increase of the constant ω for the preferred model type II, but would suggest a volatility increase for type I models.

Regarding the dynamics of the conditional volatility process, both model types suggest a post-futures decrease in the reactivity of financial market volatility to recent news given by the decrease in the first ARCH term α_1, and a post-futures increase in volatility persistence given by the increase in the first GARCH term β_1 as well as in the sum of ARCH and GARCH terms. Following Ross (1989) and Antoniou and Holmes (1995) the reactivity of financial market volatility to recent news correlates to the prevailing degree of market efficiency. It has been argued that a higher reactivity of financial market volatility speeds up the price discovery process so that asset prices reflect their fundamentally justified levels more quickly which is socially beneficial. Therefore, our results suggest a deterioration

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[6] The GARCH(4,1) model has been excluded from the further analysis since it shows some negative coefficients for the post-futures period and the parameter constraints of Nelson and Cao (1992) cannot be applied to prove whether this model specification guarantees a positive conditional variance.

of the fundamental price building process related to futures trading. This finding is supported by the increase in the persistence of information which could be interpreted as high degree of uncertainty about previous news (cf. Antoniou and Holmes, 1995).

The impact of DAX futures trading on the long-term average level of conditional volatility remains undetermined for our preferred type II models since the value of the unconditional volatility is not defined for the post-futures sample. Results for type I models would suggest a post-futures increase in the long-term average level of conditional volatility.

To analyse whether the observed changes in the estimated model parameters of the conditional variance equation are actually statistically significant, a two-sample t-test is conducted. The results for the respective one-sided hypotheses are summarized in table 3. As can be seen, the findings of the descriptive analysis of the pre- and post-futures estimation cannot be confirmed in most cases. For the preferred GARCH(2,1) model of type II only the post-futures decrease in the constant ω is significant. Applying the GARCH(1,1) model of model type II ad hoc would misleadingly suggest a significant post-futures increase in the persistence of information in addition to the significant post-futures decrease in the mean level of conditional volatility.[7]

A graphical inspection of the GARCH volatility dynamics during our sample period reveals an interesting observation. In figure 1 the dotted line shows the GARCH volatility of the GARCH(2,1) model of type II in the pre-futures period,

TABLE 2
Estimation Results for Selected Model Specifications, Estimated for Each Sub-Sample

		μ	δ	ω	α_1	α_2	α_3	β_1	β_2	$\sum_{j=1}^{p}\beta_j + \sum_{i=1}^{q}\alpha_i$	σ^2
				Excluding a Proxy Variable (Type I)							
PRE	GARCH(1,3)	3.76E-04 (0.000)	-	2.42E-06 (0.000)	0.113 (0.005)	-0.011 **(0.850)**	0.041 **(0.381)**	0.843 (0.000)	-	0.986	1.68E-04
POST	GARCH(1,3)	5.14E-04 (0.004)	-	4.92E-06 (0.020)	0.033 **(0.146)**	0.042 **(0.100)**	0.058 (0.052)	0.844 (0.000)	-	0.977	2.11E-04
PRE	GARCH(1,1)	3.63E-04 (0.000)	-	1.90E-06 (0.000)	0.121 (0.000)			0.868 (0.000)	-	0.989	1.76E-04

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[7] For type I models only the observed decrease in the reactivity of financial market volatility can be confirmed at the 1% significance level for the GARCH(1,1) model.

POST	GARCH(1,1)	5.86E-04 (0.000)	-	3.16E-06 (0.011)	0.088 (0.000)	-	-	0.896 (0.000)	-	0.984	1.97E-04
Including a Proxy Variable (Type II)											
PRE	GARCH(1,1)	-2.67E-05 **(0.723)**	1.140 (0.000)	1.57E-06 (0.000)	0.141 (0.000)	-	-	0.814 (0.000)	-	0.955	-
POST	GARCH(1,1)	-1.57E-05 **(0.587)**	1.120 (0.000)	1.56E-08 **(0.570)**	0.129 (0.000)	-	-	0.894 (0.000)	-	1.022	n.d.
PRE	GARCH(2,1)	-4.40E-05 **(0.550)**	1.143 (0.000)	1.72E-06 (0.000)	0.176 (0.000)	-	-	0.270 (0.000)	0.504 (0.000)	0.950	-
POST	GARCH(2,1)	-1.58E-05 **(0.570)**	1.120 (0.000)	1.84E-08 **(0.679)**	0.173 (0.000)	-	-	0.320 (0.036)	0.536 (0.000)	1.029	n.d

Notes: Figures in parentheses (.) indicate Quasi-Maximum-Likelihood estimated p-values.

TABLE 3

Two-Sample t-Test for All Model Specifications of Daily DAX Log-Returns Including a Proxy Variable (Type II) [a]

Two-Sample t-Test for Selected Model Specifications of Daily DAX Log-Returns Including a Proxy Variable		
H_0	GARCH(1,1)	GARCH(2,1)
$\hat{\omega}_{pre} - \hat{\omega}_{post} \leq 0$	7.444 ***	6.263 ***
$\hat{\alpha}_{1,pre} - \hat{\alpha}_{1,post} \leq 0$	0.571 n.s.	0.125 n.s.
$\hat{\beta}_{1,pre} - \hat{\beta}_{1,post} \geq 0$	-3.789 ***	-0.283 n.s.
$\left(\sum_{j=1}^{p} \hat{\beta}_j + \sum_{i=1}^{q} \hat{\alpha}_i \right)_{pre} - \left(\sum_{j=1}^{p} \hat{\beta}_j + \sum_{i=1}^{q} \hat{\alpha}_i \right)_{post} \geq 0$	-0.461 n.s.	-0.288 n.s.

Notes: *, ** and *** indicates significance at the 10%, 5% and 1% significance level, respectively, whereas "n.s." indicates no significance at the aforementioned significance levels. For the one-tailed null hypothesis the critical values of the t-statistic are 1.281, 1,645 and 2,326.
[a] To account for a possible accumulation of α-errors in multiple testing, we also applied adjusted significance levels according to the Bonferroni correction (see, Miller, 1981). The previous results are confirmed except for the post-futures decrease in the reactivity to recent news which turns out to be insignificant.

FIGURE 1
GARCH Volatility of the GARCH(2,1) Model of Daily DAX Log-Returns
(Model Type II)
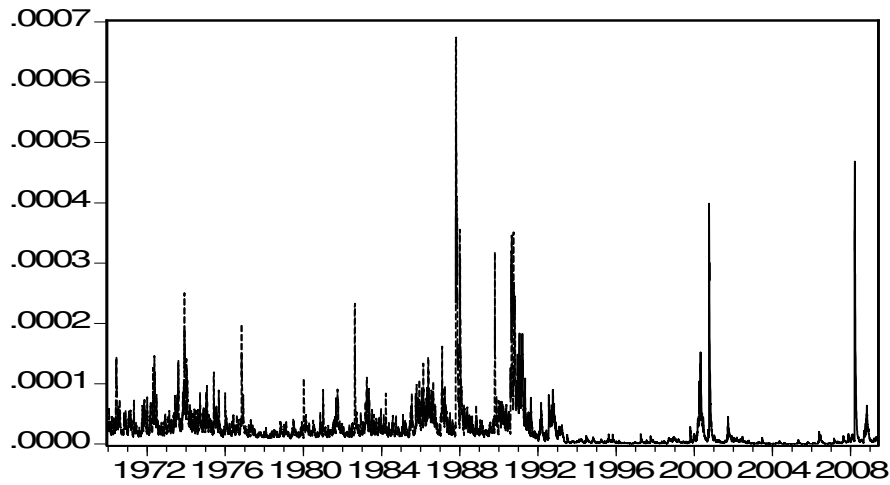
Notes: The dotted line marks the conditional variance of the GARCH(2,1) model including a proxy variable in the pre-futures period; the solid line marks the conditional variance in the post-futures period.

whereas the solid line marks its GARCH volatility in the post-futures period. As can be seen, the GARCH volatility decreases in the post-futures period as has been already suggested by the significant post-futures decrease in the mean level of the conditional volatility. However, this decrease does not occur immediately after the market for DAX futures was established, but comes fully in effect one to two years later.

4. Conclusion

Our study analyses the impact of DAX futures trading on the GARCH volatility of the underlying stock index covering a period from 1970 to 2009. In a first approach, we test for a structural break in the mean level of conditional volatility by supplementing the conditional variance equation with a dummy variable that takes zero value in the pre-futures period and a value of unity afterwards. In a second approach, we test for a structural break in the GARCH volatility process conducting a pre- and post-futures analysis. To control for the volatility impact of other market-wide factors not related to futures trading the conditional mean equation is supplemented with a proxy variable. Following Antonio and Holmes (1995) and Bologna and Cavallo (2002) a surrogate stock index for which no

derivatives products have been introduced is used for this purpose. In our case we choose the CDAX index since it is the only broad German stock index that fulfills this condition.

We argue that previous empirical results might be misleading due to methodological shortcomings, which we try to address and avoid in the present contribution. Our findings suggest that the volatility-enhancing impact of stock index futures trading found in previous studies seems to be primarily related to other market-wide factors unrelated to futures trading. Once the impact of these factors is controlled for the pure futures effect is in fact volatility-reducing. For the pre- and post-futures analysis our results show that it is crucial to check whether the observed coefficient changes are actually significant instead of drawing conclusions solely based on descriptive findings. According to the two-sample t-test the post-futures decrease in the mean level of conditional volatility is significant, whereas the observed deterioration in the fundamental price-building process cannot be confirmed. In contrast, applying the GARCH(1,1) model of type II ad hoc would suggest a significant post-futures increase in volatility persistence. However, since this model specification is not preferable according to our model selection process and shows some serious misspecifications, these findings are not reliable.

Another interesting result shows that the volatility-reducing impact of DAX futures trading is not immediately effective, but shows up with a lag. Therefore, a sufficiently long post-futures period is needed to capture the overall volatility impact of stock index futures trading adequately. By nature, the data sample of early studies is limited to a short period after the onset of the respective derivatives market. Because of both the initial inexperience with the new derivatives product and the fact that especially stock index futures are often listed in times of high volatility, interference based on data that capture just this short period immediately after the onset of the respective derivatives market may be misleading. Our extended data sample offers the possibility to capture the longer-term impact of derivatives trading on financial market volatility.

Summing up, our results confirm a stabilizing and volatility-reducing impact of DAX futures trading. Our study demonstrates the importance of appropriate model specification as well as of inferential statistic analysis.

Looking forward, the analysis of the paper can be extended in several ways. A rolling-window estimation could be applied in order to examine parameter stability. To evaluate the generality of the results further research should also analyse different stock indices, derivatives products as well as proxy variables. Finally, the GARCH volatility approach could be extended to cover further empirical characteristics of financial time series as well, e.g. volatility asymmetries that can be modelled using EGARCH model specifications.

References

Antoniou, A. and Holmes, P. (1995) Futures Trading, Information and Spot Price Volatility: Evidence from the FTSE 100 Stock Index Futures Contract Using GARCH. *Journal of Banking and Finance*, 19, 117-129.

Antoniou, A., Koutmos, G. and Pericli, A. (2005) Index Futures and Positive Feedback Trading: Evidence from Major Stock Exchanges. *Journal of Empirical Finance*, 12, 219-238.

Antoniou, A., Holmes, P. and Priestley, R. (1998) The Effects of Stock Index Futures Trading on Stock Index Volatility: An Analysis of the Asymmetric Response of Volatility to News. *Journal of Futures Markets*, 18, 151-166.

Bollerslev T. (1986) Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics*, 31, 307-327.

Bollerslev, T. and Wooldridge, J. M. (1992) Quasi Maximum Likelihood Estimation and Inference in Dynamic Models with Time Varying Covariances. *Econometric Reviews*, 11, 143-172.

Bologna, P. and Cavallo, L. (2002) Does the Introduction of Index Futures Effectively Reduce Stock Market Volatility? Is the Futures Effect Immediate? Evidence from the Italian Stock Exchange Using GARCH. *Applied Financial Economics*, 12, 183-192.

Chin, A. and Warusawitharana, M. (2010) Financial Market Shocks during the Great Depression. *The B.E. Journal of Macroeconomics*, 10 (Topics), Article 25.

Cont, R. (2001). Empirical Properties of Asset Returns: Stylized Facts and Statistical Issues. *Quantitative Finance*, 1, 223-236.

Danthine, J. P. (1978) Information, Futures Prices, and Stabilizing Speculation. *Journal of Economic Theory,* 17, 79-98.

Engle, R. F. (1982) Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, 50, 987-1007.

Gannon, G. and Au-Yeung, S. P. (2004) Structural Effects and Spillovers in HSIF, HSI and S&P500 Volatility. *Research in International Business and Finance*, 18, 305-317.

Gulen, H. and Mayhew, S. (2000) Stock Index Futures Trading and Volatility in International Equity Markets. *Journal of Futures Markets*, 20, 661-685.

Hart, O. D. and D. M. Kreps (1986). Price Destabilizing Speculation. *Journal of Political Economy*, 94, 927–952.

Herwartz, H. (2007) Conditional heteroskedasticity. In: H., Lütkepohl and M. Krätzig (Eds.). *Applied Time Series Econometrics* (pp. 197-221) New York: Cambridge University Press.

Lee, S. W. and Hansen, B. E. (1994). Asymptotic Theory for the GARCH(1,1) Quasi Maximum Likelihood Estimator. *Econometric Theory*, 10, 29-52.

Lütkepohl, H. and Krätzig, M. (2007) (Eds.) *Applied Time Series Econometrics*. New York. Cambridge University Press.

Miller, R. G. (1981) *Simultaneous Statistical Inference*. New York: McGraw-Hill.

Musiela, M. and Rutkowski, M. (2008*). Martingale Methods in Financial Modelling*. (3rd ed.). Berlin: Springer.

Nelson, D. B. and Cao, C. Q. (1992) Inequality Constraints in the Univariate GARCH Model. *Journal of Business & Economic Statistics*, 10, 229-235.

Ross, S. A. (1989). Information and Volatility: The No-Arbitrage Martingale Approach to Timing and Resolution Irrelevancy. *Journal of Finance*, 44, 1–17.

Schinasi, G. J. (2009) Defining Financial Stability and a Framework for Safeguarding It. Central Bank of Chile Working Papers, No. 550.

Schinasi, G. J. (2006) Preserving Financial Stability. IMF Economic Issues 36.

Sutcliffe, C. M. S. (2006). *Stock Index Futures* (3rd ed). Hampshire, UK: Ashgate Publishing.

Stein, J. C. (1987) Informational Externalities and Welfare-Reducing Speculation. *Journal of Political Economy*, 95, 1123-1145.

Turnovsky, S. J. and Campbell, R. B. (1985) The Stabilizing and Welfare Properties of Futures Markets: A Simulation Approach. *International Economic Review*, 26, 277-303.